

The International Transmission of US Monetary Policy:
A Case Study of South Korea

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I. Introduction

Following the recent calamity of the US financial system and correction thereof, the US government authorities have endeavored to shore up the failing economy by drastically cutting interest rates and injecting stimulus packages to the various needed areas. Both of these measures are directly related to the US money supply, particularly to increase it in order to create wealth in the short-term and revive the economic system. The impact of these policies can be deep and wide-reaching in a global scale and hardly any country and anyone can remain isolated from the wave. Of course, for that very reason, US money supply and its potential impact on various sides of the economy, domestic or abroad, has long been a popular topic of interest in macroeconomics producing vast amount of literature.

This paper looks at the history of trade between South Korea and the US as well as other economic factors to uncover the relationship between US monetary policy and the Korean economy. Inspired by the ubiquity of US monetary policy and its impact on the global arena¹, this paper will look through its certain aspects that are deeply connected to one of the fastest growing economies in Asia. A vast amount of literature has been produced explaining the relationship between US monetary shock and its

¹ For a simple example, the impact of US monetary policy changes stretches far away even to sovereign bond spreads—bonds issued by sovereigns—in emerging market.

impact on other economies; however, research about Korea has been relatively limited.

This paper revisits existing theories on foreign monetary shocks in an empirical framework using Korea as the subject country of interest. The contribution of this study is that we expand the study period to comprehensively cover decades of trade history. Having an extensive study period has several advantages: it allows us to filter minor disruptions or anomalies and observe the general development. This has the effect of stating our findings with greater certainty.

Korea has been chosen as the subject country of interest as it has undergone a dynamic history of development in a mere 50 years time span. The US is its major trading partner and is connected to the Korean economy inside and out which naturally won selection.

II. Existing Scholarly Literature Survey

In answering the posed question of how US monetary policy affects Korea's economy, much of the analysis will be based on existing studies and frameworks that have been confirmed through time. Therefore, it is critical that a review of the existing theories and empirical work on monetary transmission—domestic as well as international—be provided and determine which studies or aspects of studies apply to this research the most. In doing so, there are largely three areas of interests that need to be addressed in order to understand the full dynamics of international monetary transmission: domestic channels of monetary transmission, international channels of monetary transmission and finally, capital controls which may restrict free flow of international monetary transmission and its impact into a country. This chapter will discuss the relevant works done in these areas by first introducing the background theory and then extending it to empirical studies that have been conducted.

1) Domestic Channels of Monetary Transmission

“How does monetary policy, at the core of government's operations to bail out the economy, affect the various aspects of the economy and how is it transmitted?” This

provocative question represents one of the major ongoing disputes in macroeconomics and while many theories have been set forth to solve this puzzle, we will discuss henceforth two of the most widely trusted and cited views in this area: (i) the interest rate channel, and (ii) the credit channel.

A. Interest Rate Channel (Money View)

Simply put, the interest rate channel (the money view) explains that changes in monetary policy such as a decrease in the money supply or federal funds rate affects the economy through changes in interest rates, hence its name. Particularly, when the economy is in a bad state, the government/Federal Reserve (referred to as the Fed henceforth) can take actions to intervene. These actions consist of reducing the federal funds rate, expanding the monetary base by purchasing bonds in the market (commonly referred to as the open-market operations) or imposing/relaxing regulations to bank lending practices (e.g., changing reserve-requirement ratio). All these actions inject liquidity to the market by practically releasing more money in circulation and in the short term, these actions effectively bolster the economy.

Let us walk through a simple example to see more clearly how this works. To

keep the story simple suppose that there are two assets—money and bonds.² In a monetary expansion, the central bank increases the reserves, strengthening the banking system's ability to sell deposits. Depositors (households), faced with increased supply of money, must then hold more money and less bonds in their portfolios. If prices do not instantaneously adjust to changes in the money supply, the increase in household money holdings represents an increase in real money balances (remember, real money balances is equal to nominal money supply divided by price and since money supply increased while price stayed fixed real money balances will increase as a result). To restore equilibrium, the real interest rate on bonds declines, lowering the user (i.e., issuers of these bonds) cost of capital for a range of investment activities, and interest-sensitive spending increases. Note that increased household money holdings translate into increased spending which together with increased investment activities helps the economy to expand. In the long run, however, prices will adjust and higher inflation will absorb the effects of the economic expansion.

While the money view is widely accepted as the benchmark or “textbook” model for analyzing effects of monetary policy on economic activity, its completeness has been in doubt and an alternative proposition, the credit view, has been put forward

² This example is borrowed from R. Glenn Hubbard's *Is there a “Credit Channel” for Monetary Policy?* published in May/June 1995 Review from the Federal Reserve Bank of St. Louis.

to better explain the distributional aspects of monetary transmission mechanism. More precisely, the money view has the disadvantage that it is unable to completely explain the over-reaction of output responses (GDP) to relatively small monetary innovations (Hubbard 2005, Ferri and Kang 1999, Bernanke and Blinder 1992). This will be further discussed in the following section introducing the credit view and how it complements some of the shortcomings of the traditional money view. But before we proceed any further, let us visit some of the empirical studies that hold relevance to our study.

In a recent study done by Lo (2005), the interest rate channel has been reported to be at work in propagating economic impact of interest rate shifts within a small country. Particularly, he finds that “in response to a US contractionary monetary shock, the interest rate of the small country overshoots in the short run and deflates the economy so excessively that domestic currency depreciates and net exports revive, and that, in turn, eases the negative impact on domestic output” (Lo, 2005). The results stand as a great indicator of not only an interest rate channel at work but also an international transmission channel through which US monetary shocks can dictate interest rate movements of a small country.

In another recent study done by Pobre (2003), he finds evidence of an interest rate channel in Korea as well as Thailand and Philippines. His study of the three

developing Asian countries reveals that in response to a shock to the country's policy rate (federal funds rate equivalent), the money market rate (short term interest) experiences sharp fluctuations which causes the real GDP to draw a 'hump-shape' curve. The dramatic decline in real GDP is found to be common across countries and fixed capital investment which is most interest-sensitive experiences a major blow. However, he also notices a tighter credit market conditions develop following monetary shocks which usually is an indicator of the presence of a credit channel, an alternative transmission mechanism to the interest rate channel. Similar studies (Domac and Ferri, 2005; Kim, 2007; Goh and Yong, 2007) also point to the existence of a credit channel in South Korea and Malaysia after accounting for the effects of an interest rate channel in transmitting monetary policy shocks. (Hubbard, 1995; Pobre, 2003; Lo, 2005, Domac and Ferri, 2005; Kim, 2007; Goh and Yong, 2007)

B. Credit Channel (Credit View)

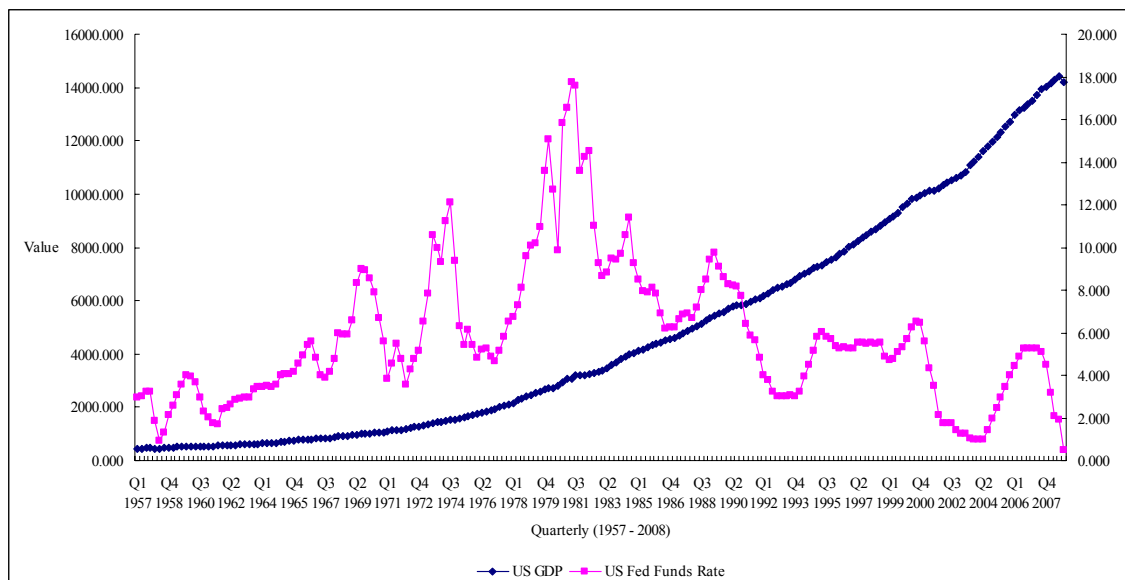
In response to some of the shortcomings identified in the previous model, many economists set forth a new strand of literature on a credit channel through which monetary actions can affect the economy unreachable by the interest rate channel. First let us focus on some of the aspects of the money view that are deemed overly simplistic

or miscalculated.

The money view asserts that changes in short-term interest rate induced by monetary shocks affect the real economy by shifting investment and consumption decisions by firms and households. It is then natural to think that changes in interest-sensitive spending in response to monetary innovations match reasonably well with observed output responses to such innovations. However, empirical studies have shown that the observed aggregate output responses to monetary innovations have been generally large compared to the relatively small estimated innovations in monetary policies.³ Below is a simple illustration of this argument depicting the evolution of US $\ln(\text{GDP})$ and Fed Funds Rate during the years 1957–2008.

³ Kashyap Stein and Wilcox (1993) have shown that the log ratio of commercial loans to commercial paper is a crucial determinant in investment and inventory spending even though interest-rate effects are usually not significant

Figure 2: US GDP vs. US Fed Funds Rate



The dark blue line represents US GDP while the one underneath colored in pink denotes the Fed Funds Rate. While there appears to be a mutual trend between the two variables, the development of US GDP is relatively more stable and constant compared to that of Fed Funds Rate. Although the graphical analysis does not reveal too much fluctuations of GDP in response to innovations in Fed Funds Rate, in the simplest terms, we can easily see that the relationship between the two variables cannot be reasonably defined linearly or in any other similar way. Thus it is natural to beg for an alternative way to explain the linkage between output and interest rates.

The search for a transmission mechanism broader than the interest rate channel reflects two concerns, one “macro” and one “micro” (Hubbard 1995). The macro concern, discussed earlier, attempts to explain the considerable fluctuation in aggregate

demand other than using simple changes in interest rates. Indeed, there seems to be other latent factors influenced by interest rate changes that in turn also effect changes in investment and/or gross output. Efforts by macroeconomists to uncover such factors have led to the development of an accelerator model establishing a propagation mechanism whereby even a minimal innovation to interest rate can be magnified.

The micro concern relates to the growing strand of literature studying informational imperfections in insurance and credit markets. According to this line of inquiry, the informational asymmetry between borrowers and lenders lead to an increased gap in external cost of financing and internal finance. This particular notion of a gap between the cost of external finance and internal finance for borrowers is central to the idea of credit channel which separates itself from the traditional money view. In this context, the credit view offers channels through which monetary policy can affect this gap (Hubbard, 1995). That is, the credit view aims at explaining how external financing “premium” accelerates the whole process of monetary shocks to the economy. We now proceed to study two such channels discussed in earlier work. (Hubbard, 1995; Hulsewig, Mayer, and Wollmershauser, 2005; Copelman and Werner, 1997; Lane, 2001; Bernanke and Blinder, 1992; Agung, 2002; Mishkin, 2001)

i) *Balance Sheet Effect*

The fundamental building block of the credit view assumes that certain borrowers face high external financing cost. In addition, the accelerator model previously mentioned argues that the spread between the cost of external and internal funds varies inversely with the borrower's net worth (Hubbard 1995). Intuitively, this assertion makes perfect sense since low net worth represents significant amount of risk to the lender, and therefore, the borrower must compensate the lender for taking any additional risk. So how would this be any important in explaining the effects of monetary shocks to the economy? First, for the sake of simplicity, let us assume borrower's net worth to be total asset minus total liability. Under this assumption and within the context of the accelerator model, given a contraction in the money supply and the ensuing increase in real interest rate will adversely affect firms' balance sheet by increasing their debt-service burdens (liability) and reducing the present value of collateralizable net worth. Now, with their net worth suddenly having declined in value, firms react to the increased marginal cost of external financing by cutting down desired investment spending and employment programs. This approach implies that spending by low net worth firms will fall significantly following a monetary contraction. (Mishkin, 2001; Choi and Cook, 2004; Kim, 1999; Wesche, 2000)

ii) *Bank Lending Channel*

The second channel stresses that some borrowers depend heavily on banks for external funds, and that policy actions can have a direct effect on the supply of loans. When banks are subject to legal restrictions on their lending practices (e.g., reserve requirement ratio) a contraction in the money supply can drain reserves and possibly decrease banks' ability to lend. As a result, credit allocated to bank dependent borrowers may fall, inducing these borrowers to curtail spending. In the IS-LM model⁴ framework, this represents leftward shift in both the IS and LM curves in response to monetary contraction. Alternatively, an adverse shock to banks' capital could decrease both banks' lending and the spending by bank dependent borrowers. Such bank lending channel magnifies the decline in output as a result of the monetary contraction, apart from the interest rate channel.

The recent financial crisis and the government's action to cope with this calamity is a living example of this channel at work. In today's tight credit conditions, it became incredibly difficult for any individual or firm to apply for a loan. This comes as no surprise as banks are now more careful in deciding whom to lend than in the past

⁴ The IS-LM model is a well supported, regarded theory in economics explaining the short run fluctuations in interest rate and output. The IS curve is a downward sloping curve representing savings and investment which together with the LM curve, an upward sloping curve, determines the equilibrium interest rate and output in an economy. Any external shocks (e.g., oil shocks, weather shocks, increase in taxes, etc.,) may shift them up and down until they adjust and come back to a new equilibrium. please just reference a textbook here. Say Krugman and Obstfeld?

days, and furthermore, banks have raised premiums attached to their loans (i.e., external cost of financing has gone up). Firms, unable to finance new initiatives, must forego every new lucrative investment opportunities which aggravates the already tormented state by further reducing their net worth which, in turn, raises the cost of external financing even further. In response to such a vicious cycle, the government has decided to step in to facilitate investment spending of firms and inject liquidity into banks' balance sheets by reducing fed funds rate to an unprecedented zero percent level and lending money to financial intermediaries. This whole process is founded on the premise that government's expansionary efforts will flow through the bank lending channel to increase bank reserves, increase loan supply, facilitate investment spending and eventually turn around the current economic crisis. Of course, the interest rate channel is also at work in that cheap capital (zero-percent short term interest) will stimulate interest-sensitive spending, but only in much simpler way.

In a study done by Kim (1999) to identify a credit channel at work, he finds convincing evidence that credit channel indeed played a key role in transmitting monetary shocks, especially following the Asian Financial Crisis in 1997. He observes that in response to a tightened monetary policy, bank lending (loan supply) experiences a marked decline which plays a key role in amplifying the real effects of stringent

money supply. Other studies done by Carpenter (1999) and Ferri and Kang (1999) in the same period also unanimously report the existence of a distinct credit channel at work following the financial crisis during 1997. (Kim, 1999; Bernanke and Blinder, 1992; Copelman and Werner, 1997; Ferri and Kang, 1999; Carpenter, 1999 Hulsewig, Mayer, and Wollmershauser, 2005)

2) International Monetary Policy Transmission Mechanism

So far, we have discussed monetary policy and its transmission mechanism within a closed economy framework. Our analysis need not stop here, however. In order for us to analyze the effect of US monetary policy on the Korean economy it is crucial to extend our analytical framework to an international level. The crux of models of international monetary transmission is the subsequent adjustment of exchange rate to restore equilibrium after a certain shock is introduced. This section will contribute to discussing two of the main stream theories on international monetary transmission related to this study.

A. Mundell-Fleming Model

The Mundell-Fleming model was first set forth by Robert Mundell and Marcus

Fleming. The model is an extension of the standard workhorse in macroeconomics—the IS-LM model—to an open economy and is widely praised for integrating international capital flows into macroeconomic analysis. The country in consideration is assumed to be a small open economy acting as a price taker unable to exert any influence on the rest of the world. The model states that the relationship between nominal exchange rate and output can be explained by the interaction of three equations—IS-LM and Balance of Payment—in the short run. More formally (Mankiw, 2002):

$$\text{IS Curve: } Y = C(Y - T) + I(r) + G + CA(\epsilon, Y, Y^*)$$

$$\text{LM Curve: } M/P = L(r + \pi^e, Y)$$

$$\text{Balance of Payment Curve: } RG = CF(r - r^*) + CA(\epsilon, Y, Y^*)$$

Where (in order of appearance):

$Y \equiv$ output;

$C \equiv$ consumption;

$T \equiv$ taxes;

$I \equiv$ investment;

$r \equiv$ domestic real interest rate;

$G \equiv$ government spending;

$CA \equiv$ current account (also net exports);

$\epsilon \equiv$ exchange rate (foreign currency in terms of domestic currency);

$Y^* \equiv$ foreign output;

M ≡ money supply;

P ≡ price level;

L ≡ money demand;

π^e ≡ expected inflation;

RG ≡ reserve gain (should equal zero in equilibrium);

CF ≡ capital account;

r^* ≡ foreign real interest rate.

And the following are assumed to hold:

$$\frac{dC}{d(Y - T)} \equiv C_{Y-T} > 0 \quad (\text{Disposable income and consumption have a positive relationship})$$

$$\frac{dI}{dr} \equiv I_r < 0 \quad (\text{Real interest rate and investment have a negative relationship})$$

$$\frac{dNX}{d\epsilon} \equiv NX_{\epsilon} > 0 \quad (\text{Exchange rate and net exports have a positive relationship})$$

$$\frac{dNX}{dY^*} \equiv NX_{Y^*} > 0 \quad (\text{Foreign output and net exports have a positive relationship})$$

$$\frac{dL}{dY} \equiv L_Y > 0 \quad (\text{Domestic output and liquidity have a positive relationship})$$

$$\frac{dCF}{d(r - r^*)} \equiv CF_{r-r^*} > 0 \quad (\text{Interest rate differential and capital account have a positive relationship})$$

Note that in order for the second equation to hold, the Marshall-Lerner condition must hold where the difference between elasticity of exports and imports must be greater than 1. In the short run, however, due to price stickiness price may not adjust instantaneously which may result in the violation of this condition. A major advantage

of this model arises from its flexibility to accommodate both fixed and flexible exchange rate systems which works well with Korea as it witnessed a shift in its exchange rate regime during the 1990s. (Mankiw, 2002 and Obstfeld, 2001)

B. Obstfeld-Rogoff Redux Model

The Obstfeld-Rogoff model was developed in 1995 borrowing certain underlying concepts from Mundell-Fleming while significantly departing in other assumptions. The mathematical foundation of this model goes well beyond the scope of this research and will thus be excluded; however, the implications of the model holds direct relevance to our analysis and will thus be discussed. The major assumptions of the model are as follows: 1) A model with two large countries (feedback between countries); 2) Prices are sticky in the short run and thus real exchange rate fluctuate; 3) When net exports are in disequilibrium countries change their wealth by saving/spending; 4) And this saving/spending is captured by the consumer's utility function through demand for real money balances; 5) Leisure is valuable (there is a tradeoff between labor and leisure). With the above setup in mind, consider a

Under a fixed exchange rate regime, Lo (2002) finds that an increase in the interest rate of a large country will impact the small open economy in the short run by:

1) increasing the nominal interest rate and 2) decreasing domestic output while price, real exchange rate and current account remain unaffected. In the long run, prices decrease to adjust while all other variables stay fixed. In an empirical investigation, Lo finds convincing evidence of the Redux model at work in the short run. Following a contractionary monetary shock of the US, Hong Kong experiences a significant increase in nominal interest rate and output reduction. Net exports revive contrary to theoretical predictions by Mundell-Fleming and Obstfeld-Rogoff. The author explains that net exports revive in the short run possibly due to reduced cheaper goods and services from Hong Kong in real terms, albeit the faster upward adjustment in net exports than in downward prices on the immediate run. (Obstfeld, 2001; Lo, 2002)

3) Capital Controls

Following the Bretton Woods Agreements in July 1944, the world entered into a managed fixed exchange rate system maintained by fixing currency value in terms of gold and IMF acting as an international financial intermediary bridging temporary imbalances of payments. In the wake of 1970's with the development of a complex financial system, the system collapsed after the United States unilaterally terminated convertibility of the dollar to gold. This action was soon followed by other developed

nations and the world quickly transformed to adopt flexible exchange rate regime where currency value was solely determined by free market forces. The world at present is majority flexible exchange rate driven as a result while a few other countries persist in having a pegged regime for strategic reasons.

In the case of Korea, the adoption of flexible exchange rate system came into serious consideration only with the occurrence and aggravation of the Asian Financial Crisis in late 1997. Prior to this event, Korea managed to maintain what is called a market average rate system—a semi-flexible exchange rate regime—from 1990 in which the exchange rate was determined by supply and demand of foreign reserves. Going even further back in time, Korea, for a decade time from 1980, maintained a currency basket peg system in which the currency was linked to a basket of multiple currencies. Before we move on to discussing the significance of introducing time differential to capture the effect of having different exchange rate regimes on monetary transmission, it is worth mentioning the opposing literary view that capital controls are irrelevant in the international transmission of US money shocks. In particular, Rodrik (1998) finds no evidence of a positive correlation between capital account openness and growth or investment/GDP ratios and argues against capital account convertibility (Rodrik, 1998). Furthermore, Miniane and Rogers finds that capital controls do not

insulate countries from US monetary shocks from examining a large range of country experiences. In defining capital openness, they assign countries to one of four categories, where a higher index denotes a more flexible regime. They find that countries with more stringent capital controls do experience smaller currency depreciations, but this result holds only at short horizons and only after conditioning on other country factors such as degree of dollarization. They also find that countries with stringent capital controls do not experience smaller interest rate increases in response to US contractionary monetary shocks. However, they report that the degree of dollarization does make a significant difference in transmitting these shocks. Countries that are highly dollarized experience more fluctuations in exchange rate or interest rate than countries that are not. It is important for us to make a distinction here, since this finding is crucial in deciding whether to include variables that could account for the different exchange rate regimes that Korea has went through in its history. Also, we must note that Miniane and Rogers find that US monetary shocks do influence economic factors in other countries in the short run.

Despite the strong evidence suggested by Rodrik, Miniane and Rogers, I find equally strong reasons to incorporate time differential into the model from the fact that Korea had different exchange rate regimes in different time periods and this may have

caused short run fluctuations in the variables that we study—GDP, interest rate, exports and Korea's money supply. Also, as we have seen from Minane and Rogers' study the degree of dollarization does produce a noticeable difference in transmitting monetary shocks from the US. Since Korea was less known prior to the eighties when it hosted the Olympics, foreign direct investment would have been considerably lower than in the nineties or the present. Adding to its small name, the stringent capital controls during the sixties and seventies would have prevented foreign investors from freely investing in Korea's assets. These observations provide us with good reasons to include certain variables in our models to differentiate the effect of having different exchange rate arrangements in US monetary shock transmissions. Therefore, this paper will recognize the importance of having different exchange rate regimes in different time periods and will segment time into three periods, pre-1980s, 1980s and post-1980s in accordance with the different exchange rate regimes for the three time periods. (Miniane and Rogers, 2006; Cottarelli and Kourelis, 1994)

III. Hypothesis

The primary objective of this paper is to identify the existence and estimate the form of relationship between US money supply and Korea's output, net exports, interest rate and money supply. The theoretical underpinnings of this study will adopt certain aspects of the models discussed heretofore with the obvious advantage of reproducing an eclectic model having all the strengths and fewer weaknesses. In this chapter, we try to predict the direction of influence of the variables of interest in response to changes in US money supply overtime. Here, I use the term "overtime" to denote a trend over several decades which filters minor disruptions or anomalies to convincingly suggest an "actual" relationship. While short term responses of Korea's GDP, for instance, may slightly vary across different time periods to changes in the US money supply, in aggregate, we hope to see an actual relationship between the two. Observing the impact of US monetary policy changes across multiple time periods helps in this regard.

Hypothesis 1. Korea's GDP is correlated with changes in US money supply.

First and foremost, it is important to ask whether monetary policy abroad will affect Korea's domestic output and if so, in what way. Under the Mundell-Fleming

model, Korea's output, in response to a contraction in US money supply, will experience an expansion owing to a favorable exchange rate environment which helps to improve Korea's net exports. In contrast, under the Obstfeld-Rogoff Redux model, output, in response to the same change in US money supply, will experience a substantial decline due to a surge in domestic short term interest rate. The apparent discrepancy calls for an actual estimation of the relationship to determine which model is a better fit for a small country case of Korea. Hence, the hypothesis will try to address the conflict between the two theories by first assuming that having a favorable exchange rate environment dominantly drives up the output in spite of the surge in short term interest rates, after adjusting for any other factors.

Hypothesis 2. Korea's exports are correlated with changes in US money supply.

Next, it is also of particular interest whether Korea's exports will be affected by changes in US money supply or stay unchanged. The export industry is critical to Korea's economic sustainability/ vitality. According to the Mundell-Fleming model, any changes in US money supply would shift the exchange rate so as to positively influence Korea's exports. Additionally, the model predicts that any changes in US money supply would affect US income so that it induces more spending on imports. Thus, we would

expect to observe a co-movement in Korea's exports and US money supply after adjusting for any other relevant factors.

Hypothesis 3. Korea's short term interest rate is correlated with changes in US money supply.

According to the Obstfeld-Rogoff model, any changes to the interest rate of a large country would be similarly matched by that of a small country. For example, if US money supply experiences a sharp decrease which drives up the interest rate in the short run, the interest rate of a small country would also upsurge. More practically speaking, in our case of US and Korea, US, being the large country, exhibits leadership in interest rate determination of a smaller country like Korea.

Hypothesis 4. Korea's monetary policy is correlated with US monetary policy.

This is a particularly interesting scientific hypothesis to be tested. If, for instance, we postulate that the Korean monetary authorities closely monitor US monetary policy changes and act accordingly, we immediately recognize the presence of a domestic interest rate or credit channel which can be triggered by monetary policies from abroad. It can be reasonably conjectured that, assuming US monetary policies have

direct or indirect impact on the Korean economy, Korea's monetary authorities would most likely react in some way to manage the shocks coming from US monetary changes. Going a step further, we are able to reason that in order to buffer the impact from any US monetary changes Korea would also react in some similar fashion by matching any changes from abroad. This is also the prediction laid by the Rediux model which states that any innovation to interest rate/money supply of a large country would be matched by that of a smaller country.

IV. Research Design

1) Methodology

This study will primarily rely on statistical analysis to derive an estimated relation between various Korean economic variables and US monetary policy. The statistical analysis in this paper adopts the Ordinary Least Squares method.

2) The Data

i) Source

All of the information on the variables is collected from a single source, IMF International Financial Statistics online database. While there can be many sources from which information could be gathered, IMF Statistics (www.imfstatistics.org/imf/) stands as one of the most reliable and trustworthy source for any information related to macroeconomic analysis. Moreover, the consistency and accuracy of the data is guaranteed to be of the highest quality as many economists worldwide base their works on information provided by this site. In addition, gathering information from a single source with guaranteed quality has a major advantage in that the data is consistent throughout. For example, the units in which many economic variables are expressed in

are largely the same without any significant deviations. The time at which the variables exist are also synchronized so that there are no time discrepancies between variables.

ii) Frequency

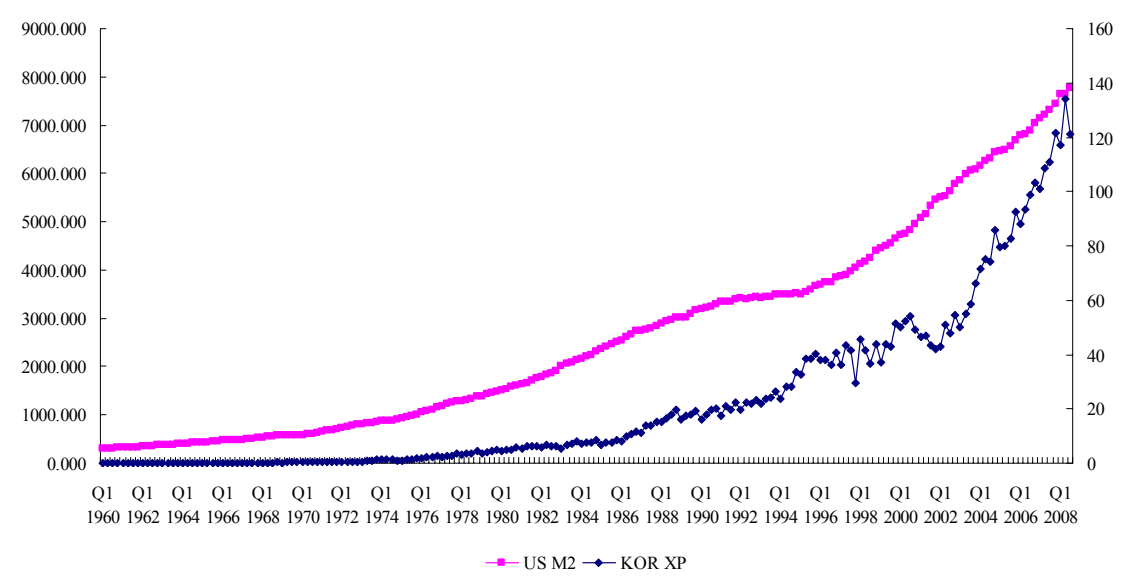
All of the variables in the model are quarterly observations. While some variables are found to be more frequent than others, synchronization of all the variables to a single frequency allowed quarterly to be the most continuous. Moreover, while the frequency may not be as continuous as daily or monthly, the observation period of our data is fairly large spanning for more than 4 decades which is enough to make powerful inferences over the course of Korea's industrialization history. As an aside, Korea achieved its independence in 1945 with the closing of World War II and suffered a civil war in 1950 until an armistice was signed three years after; as a result, Korea started relatively late in the industrialization race and having data from 1960 is the best available in the open market.

iii) Variable Specification

This section is devoted to the discussion of how the variables are specified and what meanings they hold. As US monetary policy is the crux of our model, much of the

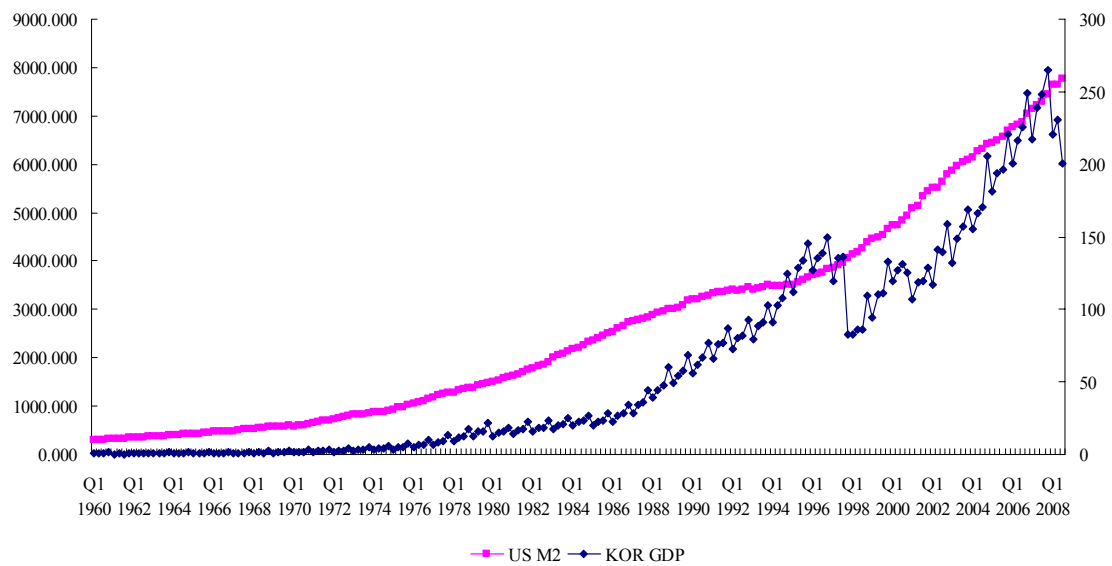
discussion will rely on the interaction of US money supply with Korea’s various economic variables of interest. Below is a graphical illustration of the relationship between US money supply and Korea’s Exports. Normalizing scale, a simple visual inspection of the graph reveals that a common trend exists between the two. For the model, both US money supply and Korea’s Exports are expressed in logarithms to fit a linear trend. This means that the two variables have been transformed to log-forms so that after the change the relationship between the two variables can be defined linearly which is crucial to the Ordinary Least Squares Method we use in this paper.

Figure 4. US Money Supply and Korea Exports Differential Over Time



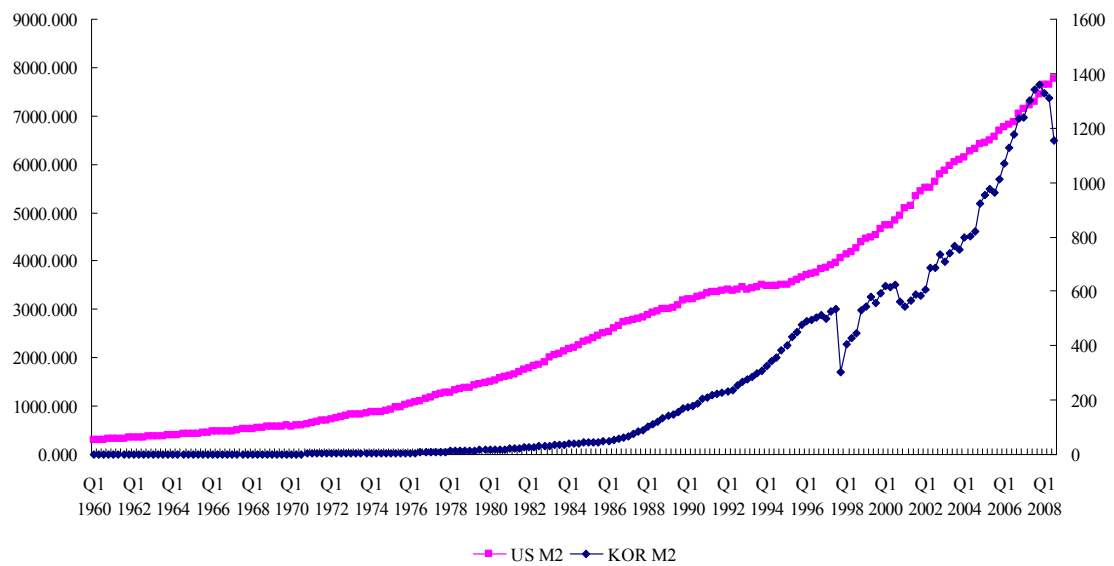
Similarly, below is a graph of US money supply and Korea GDP displaying a rather common trend of development over time. Korea GDP is also expressed in logarithmic form to better establish a linear relationship with US money supply.

Figure 5. US Money Supply and Korea GDP Differential Over Time



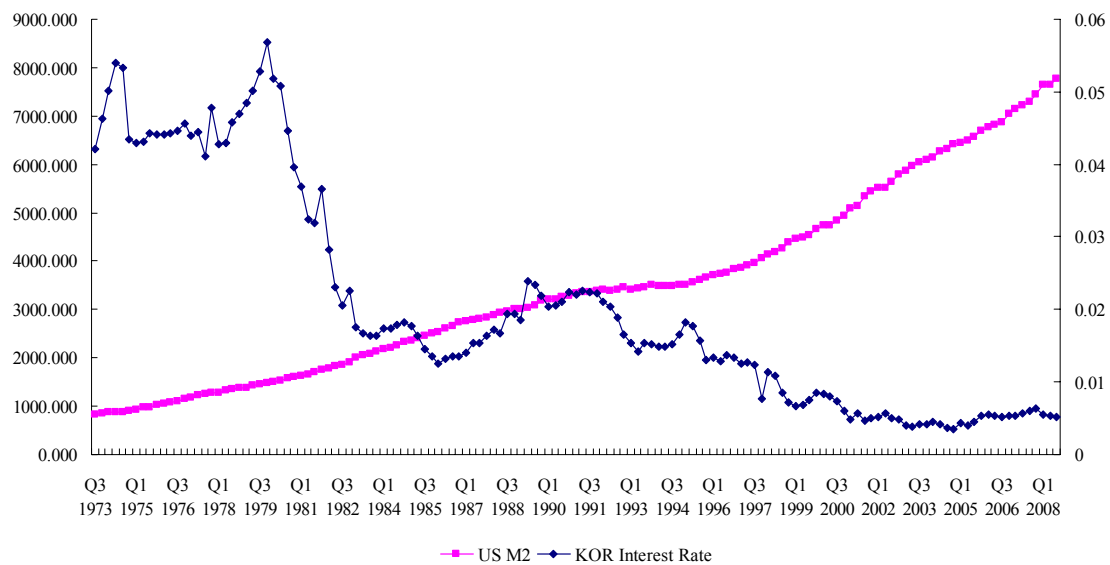
Likewise, money supplies of the two countries also exhibit a common trend. It may well be postulated that the monetary authorities in Korea closely monitor and benchmark US monetary policies. Korea money supply is also expressed in logarithmic form for the same reasons above.

Figure 6. US & Korea Money Supply Differential Over Time



In contrast to the earlier developments, this one finds that US money supply and Korea interest rate have evolved opposite to each other, directly relating to the Obstfeld-Rogoff model discussed previously. To see how this is true, remember that an increase in the money supply causes the interest rate to decline. Note that any variables that come in percentages, including this one, have not been converted to logarithmic form as doing so would result in variable misspecification and biased estimators.

Figure 7. US Money Supply and Korea Interest Rate Differential Over Time



Be aware that the graphs themselves are not much revealing other than a general trend of the variables and a formal statistical testing must be accompanied to draw any useful conclusions. To check for the linearity of the models please refer to the scatter plots in Appendix I.

3) The Models

The first model is estimates output responses to changes in US monetary policy. As stated from one of the hypotheses earlier, this equation will estimate the relationship between Korea's GDP and US money supply along with other relevant variables. Korea's current output is regressed on previous period's GDP, US money supply, domestic money supply and interest rates. Note that, for all of the four models dummy variables have been included to account for the time differential effects of US monetary policy. *Hypothesis 1:*

$$\text{i) } GDP_t = \beta_0 + \beta_1 GDP_{t-1} + \beta_2 M^*_{t-1} + \beta_3 M_{t-1} + \beta_4 r_{t-1} + \delta_0 \text{low} + \delta_1 \text{mid} + \delta_2 \text{low} \times M^*_{t-1} + \delta_3 \text{mid} \times M^*_{t-1} + U_t$$

Likewise, the second model estimates exports responses to changes in US monetary policy. Exports is regressed on itself for the previous period as well as US money supply, US GDP and domestic interest rates. *Hypothesis 2:*

$$\text{ii) } XP_t = \beta_0 + \beta_1 XP_{t-1} + \beta_2 M^*_{t-1} + \beta_3 GDP^*_{t-1} + \beta_4 r_{t-1} + \delta_0 \text{low} + \delta_1 \text{mid} + \delta_2 \text{low} \times M^*_{t-1} + \delta_3 \text{mid} \times M^*_{t-1} + U_t$$

The third equation adopts a very similar approach to estimating the relationship between domestic interest rate and US interest rate as well as money supply. This model attempts to check the validity of the claim set forth by Obstfeld-Rogoff's on importing interest rate changes from abroad. According to the Obstfeld-Rogoff model, any shift in a large country's interest rates should be followed by a likewise shift in the small country's interest rates. *Hypothesis 3:*

$$\text{iii) } r_t = \beta_0 + \beta_1 r_{t-1} + \beta_2 r^*_{t-1} + \beta_3 M^*_{t-1} + \delta_0 \text{low} + \delta_1 \text{mid} + \delta_2 \text{low} \times M^*_{t-1} + \delta_3 \text{mid} \times M^*_{t-1} + U_t$$

The last equation is included to observe Korea's monetary policy stance on US monetary policy actions. As mentioned in Section III in this paper, this equation is particularly revealing in answering the question whether there is interest rate channel or credit channel at work magnifying the impact of initial monetary shocks from abroad.

Hypothesis 4:

$$\text{iv) } M_t = \beta_0 + \beta_1 M_{t-1} + \beta_2 M^*_{t-1} + \delta_0 \text{low} + \delta_1 \text{mid} + \delta_2 \text{low} \times M^*_{t-1} + \delta_3 \text{mid} \times M^*_{t-1} + U_t$$

Where:

GDP_t is the natural log of Korea's GDP at time t ;

GDP^*_t is the natural log of US GDP at time t ;

M_t is the natural log of Korea's M2 Money Supply at time t ;

M^*_t is the natural log of US M2 Money Supply at time t ;

XP_t is the natural log of Korea's Net Exports at time t ;

r_t is the yield on a 3-year Korean Treasury bond at time t ;

r^*_t is the yield on a 10-year US Treasury bond at time t ;

low is a dummy variable for time period prior to 1980;

mid is a dummy variable for time period between 1980 and 1990;

$low \times M^*_t$ is an interactive term of US M2 Money Supply and low at time t

$mid \times M^*_t$ is an interactive term of US M2 Money Supply and mid at time t

U_t is the error or disturbance term.

V. Empirical Results and Discussions

The results obtained for the models are as follows (standard errors in parentheses):

$$\begin{array}{cccccccccc} \text{i) GDP}_t = & 1.740 & -0.104\text{GDP}_{t-1} & -0.174\text{M}^*_{t-1} & +0.083\text{M}_{t-1} & +0.005r_{t-1} & -7.746\text{low} & +0.199\text{mid} & +1.111\text{low}\times\text{M}^* & -0.019\text{mid}\times\text{M}^* \\ & (1.103) & (0.095) & (0.164) & (0.099) & (0.006) & (1.560) & (1.066) & (0.215) & (0.132) \end{array}$$

R-square = 0.9867

Adj. R-Sq = 0.9858

F value = 1210.22

Estimation of the first model tells us that current GDP is negatively correlated previous US money supply holding other factors constant. Negative correlation between current GDP and previous quarter's US money supply implies that quarterly observations follow the pattern described by the Mundell-Fleming model and is consistent with our primary hypothesis. The F-statistic is extremely high which suggests that, overall the coefficients of the variables are significantly different from zero.

$$\begin{array}{cccccccccc} \text{ii) XP}_t = & -6.569 & +0.572\text{XP}_{t-1} & +0.957\text{GDP}^*_{t-1} & -0.064\text{M}^*_{t-1} & +0.004r_{t-1} & -1.037\text{low} & -0.320\text{mid} & +0.163\text{low}\times\text{M}^* & +0.046\text{mid}\times\text{M}^* \\ & (1.392) & (0.075) & (0.284) & (0.224) & (0.004) & (1.135) & (0.720) & (0.156) & (0.092) \end{array}$$

R-square = 0.9932

Adj. R-Sq = 0.9928

F value = 2389.39

Estimation of the second model also coincides with our prediction about the relationship between US money supply and Korea's exports. A negative coefficient for

US money supply variable suggests that contraction (expansion) in the US money supply results in expansion (contraction) in Korea's exports which was discussed in our second hypothesis.

$$\text{iii) } r_t = \begin{matrix} 7.941 \\ (7.491) \end{matrix} + \begin{matrix} 0.874r_{t-1} \\ (0.047) \end{matrix} + \begin{matrix} 0.133r^*_{t-1} \\ (0.083) \end{matrix} - \begin{matrix} 0.891M^*_{t-1} \\ (0.830) \end{matrix} - \begin{matrix} 12.433\text{low} \\ (12.708) \end{matrix} - \begin{matrix} 9.833\text{mid} \\ (1.751) \end{matrix} + \begin{matrix} 1.834\text{low} \times M^* \\ (1.052) \end{matrix} + 1.188\text{mid} \times M^*$$

R-square = 0.9672

Adj. R-Sq = 0.9655

F value = 560.73

Estimation of the third model tells us that Korea's interest rate imitates or follows the movement of US interest rates. This has precisely been the proposition set forth in our third hypothesis which was based on the Obstfeld-Rogoff model.

$$\text{iv) } M_t = \begin{matrix} -0.736 \\ (0.430) \end{matrix} + \begin{matrix} 0.899M_{t-1} \\ (0.028) \end{matrix} + \begin{matrix} 0.165M^*_{t-1} \\ (0.066) \end{matrix} - \begin{matrix} 1.294\text{low} \\ (0.432) \end{matrix} - \begin{matrix} 1.475\text{mid} \\ (0.653) \end{matrix} + \begin{matrix} 0.165\text{low} \times M^* \\ (0.053) \end{matrix} + \begin{matrix} 0.179\text{mid} \times M^* \\ (0.082) \end{matrix}$$

R-square = 0.9988

Adj. R-Sq = 0.9987

F value = 25491.1

The last result also coincides with our last prediction that Korea's money supply may follow the movement in US money supply in order to restore balance in the Korean economy that might have been affected by the changes in foreign money supply.

In what follows, we discuss each of the estimated results in greater detail. With respect to the first regression, we found that Korea's GDP is negatively correlated with US money supply. In conjunction with the last model and with certain reasonable assumptions this may yield a potentially interesting interpretation of the relationship between Korea's GDP and US money supply. First let us review what the theory predicts. According to the Mundell-Fleming model of international monetary transmission, an increase in US money supply would stimulate domestic economic activity, at least in the short run, and an expansion in output would follow suit. This can lead to an increase in import demand from Korea,. Accordingly, an increase in US money results in wealth creation in Korea. Same results would be expected from the Obstfeld-Rogoff model, albeit through slightly different mechanism. An increase in US money supply would pull down the domestic interest rate which also similarly affects Korea's interest rate. Having lower interest rate would spur investment activity and, as a result, Korea's GDP would also go up. This does not seem to be the case in our estimated model, however.

The model predicts that, on average, a marginal percentage increase in US money supply would change Korea's GDP by (17.4)%. This is a sizeable spillover effect. To gain further insight, consider the last estimated model, in which US money supply

and Korea's money supply share a positive correlation that is statistically significantly different from zero. This means that an increase in US money supply would induce a similar increase in Korea's money supply as well. But, from above, we know that an increase in one country's money supply stimulates domestic economic activity and expands output. Therefore, it may be the case where the effect of shifts in US money supply on Korea's output is felt through a likewise adjustment in Korea's money supply. To corroborate our argument, the parameter estimate for M_{t-1} in the first equation is positive with high level of significance. And from the last equation, we also know that Korea's money supply is positively influenced by US money supply, validating the argument.

There are other possible reasons include the inclusion of dummy variables which might have diluted its true impact on Korea's money supply. This would be analyzed in depth in the following section for robustness; however, this seems unlikely considering that the two nations were less connected prior to 1990 (when Korea floated its exchange rate) and the impact of US money supply was less felt.

Another possibility would be due to technical limitations of the model. The most prevalent technique used by the academia for studying any trend in macroeconomics including monetary transmission mechanism is the Vector Auto

Regression (VAR) method. Since, however, the technicality of it goes well beyond the scope of this research program, the author relied on using instead the Ordinary Least Squares (OLS) method. It is certainly possible, by using an alternative method, for the results to come out differently. The details of VAR will not be discussed in this paper, but the fact remains and leaves the task for future studies.

The second model is no less interesting than the first model in the same (which?) context of interest rate spillover effects. The two main parameter estimates in the model, for US GDP and US money supply, display a significant departure from each other. While the parameter estimate for US GDP is positive as expected with a p-value of 0.1% (having a low p-value means high significance, 1-5% is considered low in standard), it is less promising for US money supply. The estimate is not only negative, opposite to what theory predicts, but also statistically not much different from zero. A possible reason for this, and also the reason why it so fascinating at the same time, could be due to the same spillover effect of US money supply on Korea's GDP. While US money supply may be linked to Korea's GDP and exports in the manner theory predicts, the alternative channel of influence may be stronger to capture most of the effect, leaving the expected channel empty and insignificant. The rest of the variables also suffer from statistical insignificance, but with the only exception of Korea's interest rate,

the coefficients come out as expected.

The third model fails to find any statistically significant relationship between Korea's interest rate and the designed variables except for US interest rate at the 11% significance level. As with all other models, the dependent variable is regressed on an intercept, itself, US monetary policy measure, and plain as well as one-factor interactive dummies. While the US money supply is estimated to be insignificant, the key focus here would be on the US interest rate. The model predicts that, on average, a unit percentage movement in US 10 year Treasury yield would change Korea's 3 year Treasury by 13.256%. This partially conforms to what the Obstfeld-Rogoff model suggests. In the event of a foreign money supply decrease, the theory predicts that country's interest rate increase should be matched by a likewise increase in the domestic interest rate. While we cannot say anything about a reduction in the US money supply, the original catalyst, we know that the two country's interest rate have been generally observed to move in tandem as claimed by Obstfeld and Rogoff's strong interest rate linkage. If this is true, then from our earlier discussion about the two channels of monetary transmission (i.e., interest rate channel and credit channel) we are allowed to make policy recommendations regarding fighting off interest rate induced economic slowdowns which will be discussed later on.

The last one is for testing Korea's monetary policy stance on known US monetary policy actions. I use the term "known" here to denote the fact that one year lag of US money supply was used to fit this model. All the values are significant at the 5% level with the expected signs. The estimated parameter value of US money supply is 0.16501 with a p-value of 0.0133 (remember, having a lower p-value corresponds to increasing power of the estimate) meaning, a one percent increase (decrease) in US money supply would be responded by a 16.501% increase (decrease) in Korea's money supply. This sheds some light on how Korean monetary authorities behave in response to a given change in US money supply.

From this model alone, a definitive answer to the reason for their matching behavior can not be extracted but one possible explanation is as follows. Monetary policy largely serves two main purposes: 1) to control for inflation and 2) to foster growth. The Fed is well known for its extensive policy tools for achieving these two goals and the recent adjustment in the Fed Funds Rate is a good example of how it reacts to economic conditions. Similarly, the Bank of Korea is concerned with the mentioned objectives and whenever it sees any potential for over-growth it may want to moderate the process for price stability. Often the two policies come in trade-offs and having both at the same time is nearly impossible. But when the US expands its

monetary base and the effect is felt on Korea's GDP, the relevant authorities may decide to trade growth for price stability and increase the money supply to match output growth. Considering that keeping inflation at a modest level is one of the most important objectives for any central bank, the argument is plausible in that it is aligned with the Bank of Korea's interest.

In what follows, we conduct robustness checks on the models we estimate. These are aimed at addressing the two assumptions that we have made throughout: (i) the importance of time dummies reflecting a shift in Korea's capital mobility over time and (ii) using money supply instead of the federal funds rate to proxy for monetary policy.

VI. Robustness

In any macroeconomic analysis, a discussion about the possible outcomes of having different assumptions for the current model must be included. Typically this is referred to as robustness analysis which tests the ability of the model to withstand external stresses or changes in procedures or circumstances. This is critical to establishing the power of any economic analysis involving statistics, and therefore, one must carefully consider all the possible variations that can affect the results. Here, two such variations are considered: 1) Models without dummy variables and 2) Models using an alternative measure for US monetary policy—the Fed Funds Rate.

1) Models Excluding Dummy Variables

Conceptually, the exclusion of dummy variables in the model would have had the effect of ignoring any time differential. In other words, since the model is estimated without taking into account the potential difference in the effect of US money supply changes on Korea's economy for different time periods, the models may lose some degree of accuracy. This is because the effect of US monetary policies in the 1970's could be different from that of 1990's but without the dummy variables to differentiate the combined effect would be reported under a single parameter for US money supply

(i.e., M^*_{t-1}).

We re-estimate our models by removing the time dummies. The results are shown in Appendix V. Observe that the models that were estimated without the dummies were not too different except for a few areas. From the first modified model, the first thing noticeable is that the effect of domestic interest rate on output has become statistically significant. In other words, the effect of interest rate on output is no longer significant when time dummies are included. That is, the interest rate after partialling out for time may not have as strong impact on domestic output as it with the time effect. This can be confirmed by the strong correlation existing between the interest rate and output which is reported in the correlation matrix on Appendix II. While interest rate alone is highly correlated with output, after the time differential has been controlled for it no longer is as important as before.

A similar case can also be found in the third equation where US money supply became statistically significant after not having any dummy variables. An interesting fact is that US interest rate has become statistically insignificant after the change, essentially swapping its statistical significance with US money supply. Since the two variables have extremely low correlation to each other (refer to Appendix II) it cannot be the case that US money supply absorbed the effect of US interest rate on Korea's

GDP. And since the two variables do not share any commonality in terms of their estimated correlation, it must be due to the same time effect discussed above.

Everything considered, we have found that time is an important factor and the inclusion of dummies does bring about a few noticeable changes. The interpretation of the results, together with the underlying theories, remain the same, nevertheless.

2) Models Using US Fed Funds Rate

In the United States, the Federal Funds Rate (FFR) is the interest rate at which private depository institutions lend balances at the Federal Reserve to other depository institutions, usually overnight (Fed Reserve Bank of New York, 2007). It is a well known policy tool of the Fed for regulating the economy and has been found to be a good proxy for forecasting future economic activities (Bernanke and Blinder, 1992). Additionally, it has been argued that US money supply is no longer an accurate measure of US' monetary policies since it has been on a stable growth for many years. It is therefore the author's reasoning that the FFR could potentially be a better measure than the money supply in reading off US monetary policy changes, and hence, the efficacy of this measure must be tested for.

Estimating the regressions in the usual OLS method, we immediately observe a

rather counter-intuitive result. US monetary policy, now measured by the FFR, is no longer decisive in determining any of the dependent variables! It certainly cannot be the case that US monetary policy's influence on Korea's economy has diminished or even disappeared after many years of advancing globalization and especially at this time when Korea is suffering together with the US in going through the mortgage crisis. Instead, the results seem to imply that the FFR is not a good proxy for US monetary policy, at least within these models. In fact, this dispels any anxiety or previous uncertainties about using US money supply and enhances the power of our original results. So, all in all, we have established that the models are quite powerful in the context of our definition of robustness and now we are finally ready to move on to summarizing the major findings of this research and make policy recommendations.

VII. Conclusion

Our analysis so far has revealed a number of interesting ways in which international transmission of monetary policies take place between the US and Korea. While some aspects appear less direct than others, it has been generally observed to have a direct effect on each other. For instance, in answering the provocative question “does Korea’s monetary policy get influenced by its counterpart in the US” we have seen that Korea’s monetary authorities routinely monitor actions by the US Fed to set directions for their own. This certainly must be the case considering that in the aftermath of the 1997 Asian Financial Crisis, Korea has adopted a free moving exchange rate system and the world is now far more integrated than before. Also by the very same token, the effects of foreign monetary actions are transmitted to Korea’s economy with less friction and with greater speed. This turned out to be the case from running the third regression where we found that the two countries’ interest rates are aligned to each other in their movements. So, for instance, if the US Fed decided to lower its monetary base target for the next year and implement its plan gradually, the change in the amount of money in circulation would decrease and would cause a direct effect on its interest rates. This would in turn influence Korea’s interest rates in such a way that it would deter investments within the country and thus contracting the overall

economic activity. This effect, as was discussed in the literature survey, becomes more pronounced with the interest rate channel or the credit channel and the impact felt is magnified to be larger than its initial shock. This comes as no surprise when we consider the globalization process we have been pushing through and the world has become essentially like a big community where every country is connected to each other politically and economically.

A very important policy recommendation before we close our discussion is that the monetary authorities in Korea recognizing the potential impact of a shift in US monetary policies and their subsequent impacts towards the Korean economy must be controlled and contained. More practically speaking, the Korean monetary officials are willing to shift domestic money supply such that it counter-balances any impact from foreign monetary shocks. Since we know that the two countries are integrated to each other in the ways that we have discussed, a policy shift from the larger economy would inevitably trickle down to impact the smaller one, creating a spillover effect on the process. Therefore, it is absolutely necessary that the effects must be closely studied for and referenced for deciding future actions to any changes in US monetary policies. This certainly has been the case throughout and it is with utmost importance that this policy be carried out in the same manner into the distant future.

Appendix I. Scatter Plots

Figure Appendix 1. Korea GDP vs. Korea M2 Scatter Plot

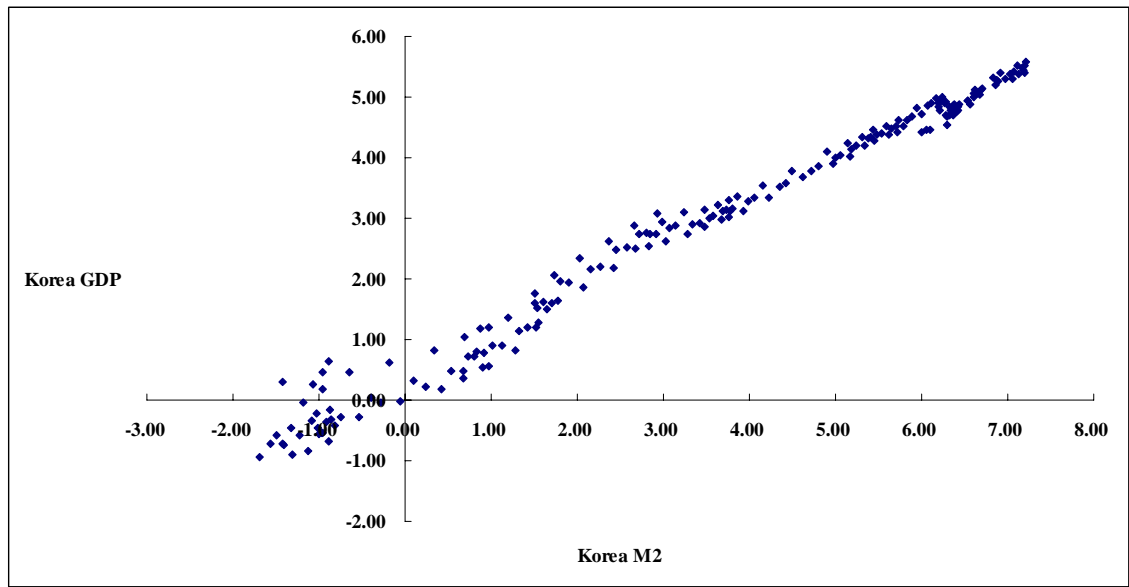


Figure Appendix 2. Korea GDP vs. Korea Interest Rate Scatter Plot

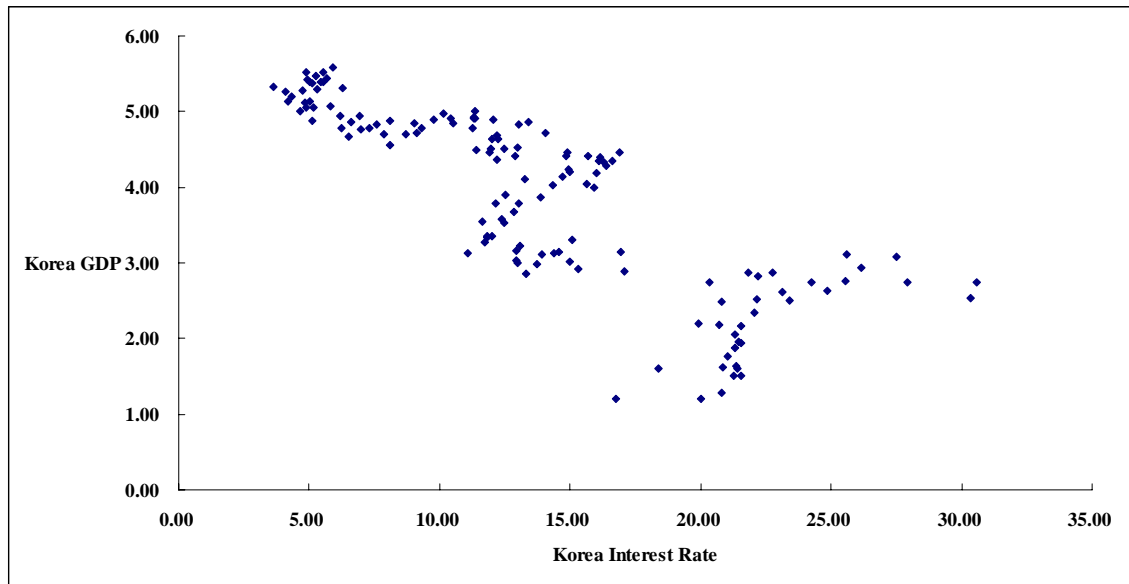


Figure Appendix 3. Korea GDP vs. US M2 Scatter Plot

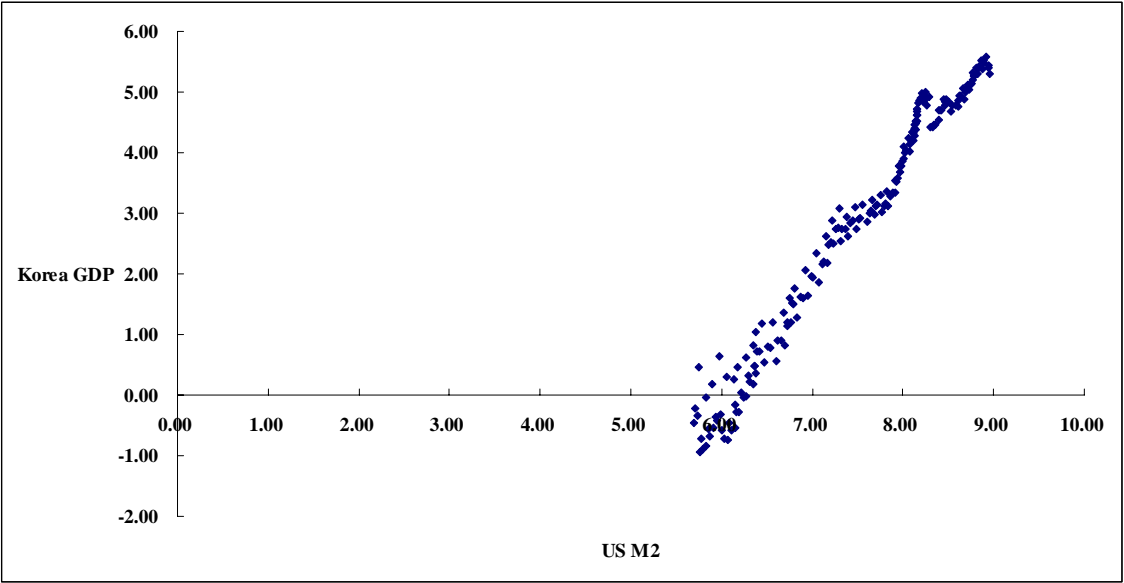


Figure Appendix 4. Korea Exports vs. Korea Interest Rate Scatter Plot

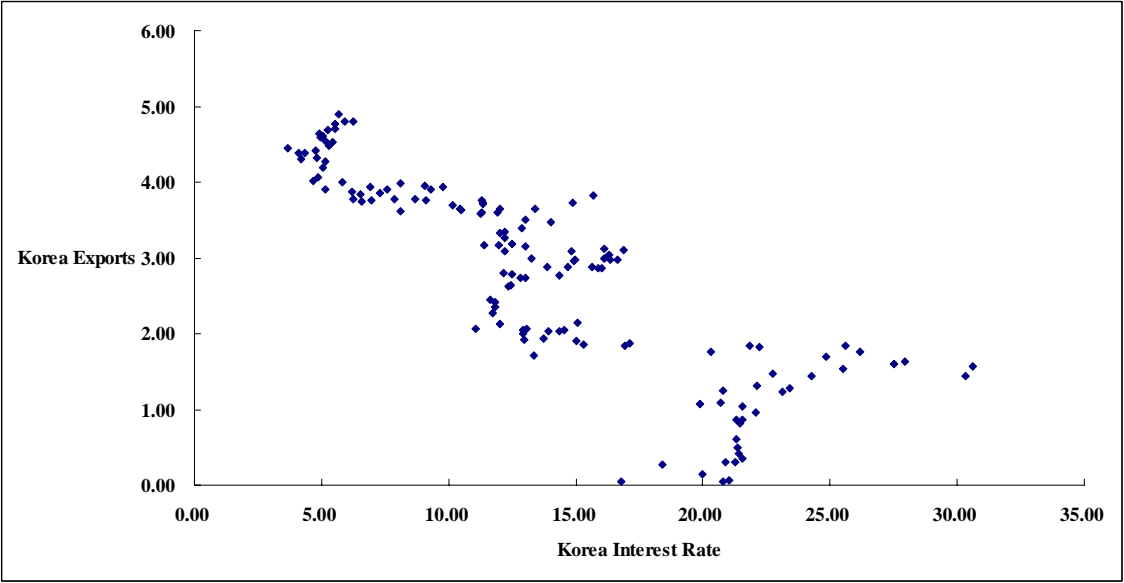


Figure Appendix 5. Korea Exports vs. US M2 Scatter Plot

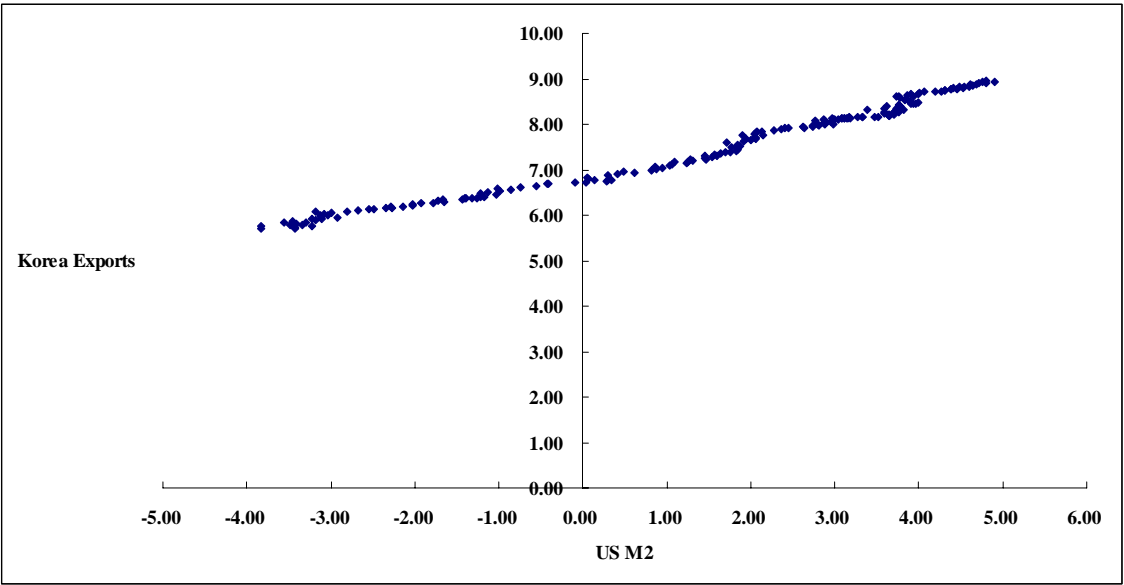


Figure Appendix 6. Korea Exports vs. US GDP Scatter Plot

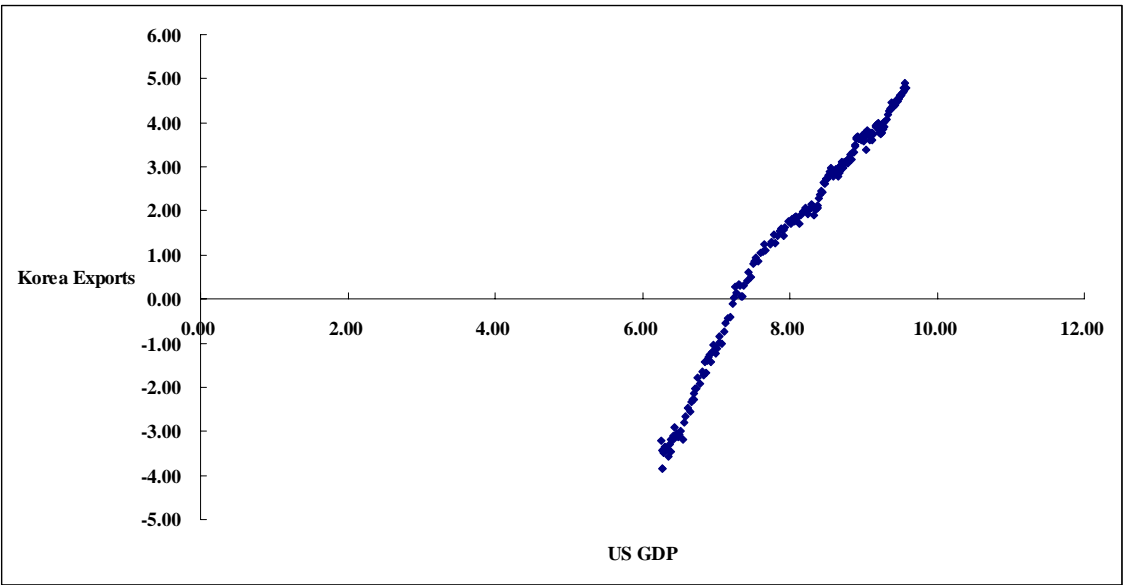


Figure Appendix 7. Korea Interest Rate vs. US M2 Scatter Plot

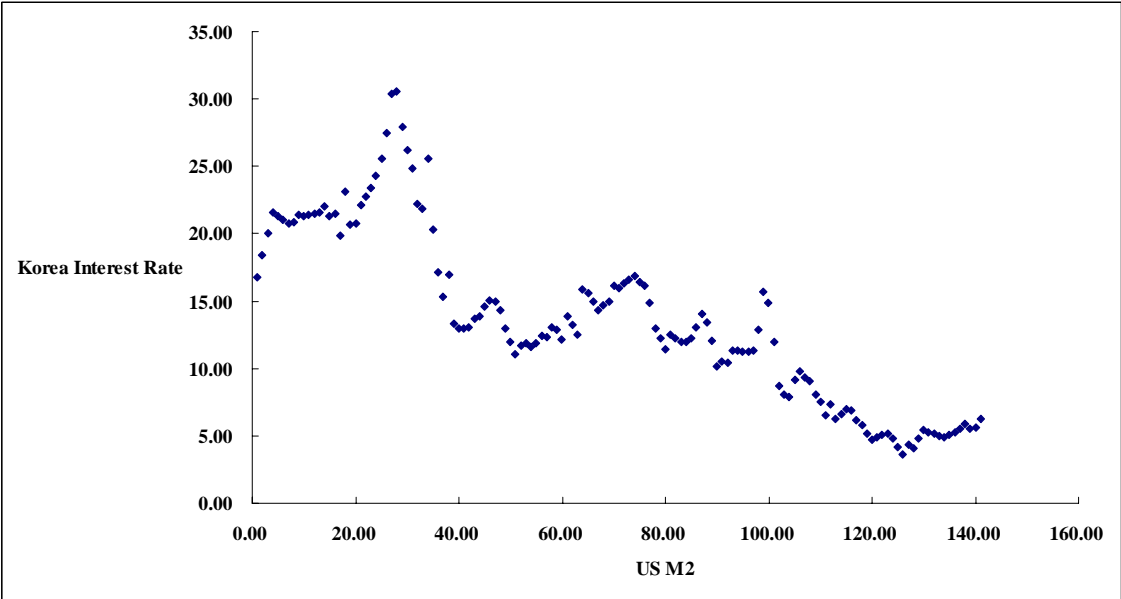


Figure Appendix 8. Korea Interest Rate vs. US Interest Rate Scatter Plot

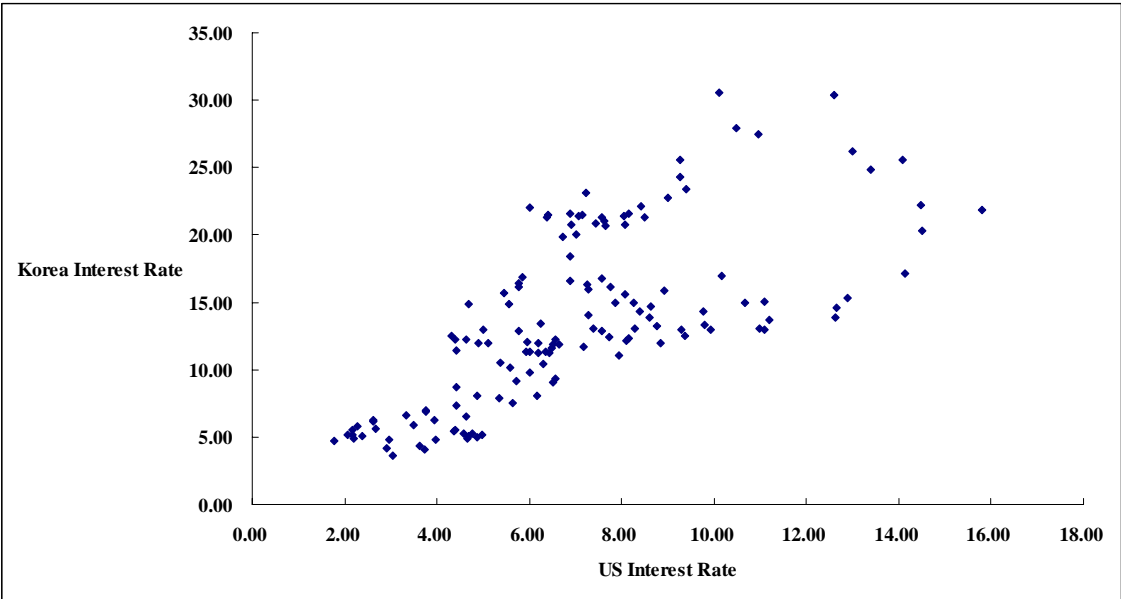
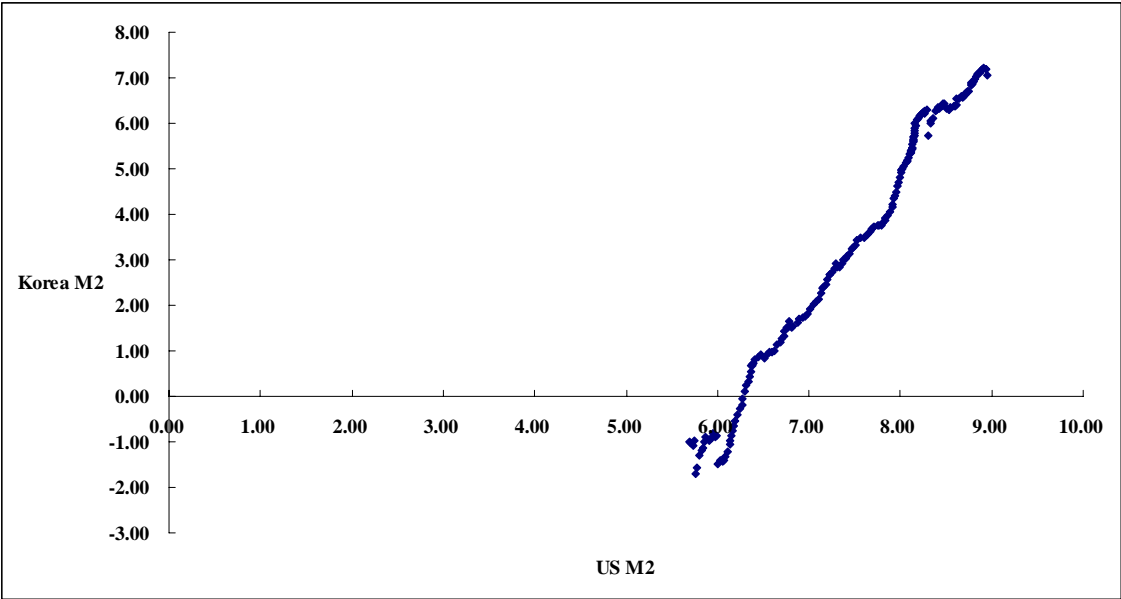


Figure Appendix 9. Korea M2 vs. US M2 Scatter Plot



Appendix II. Correlation Matrix

Pearson Correlation Coefficients

P rob > |r| under H0: Rho = 0

		GDP_t	GDP*_t	M_t	M*_t	r_t	r*_t	XP_t
GDP_t	<i>Pearson Correlation</i>	1	0.9895	0.99258	0.98734	-0.82057	0.00849	0.98777
	<i>p value</i>	-	<.0001	<.0001	<.0001	<.0001	0.9063	<.0001
	<i>N</i>	195	195	195	195	141	195	195
GDP*_t	<i>Pearson Correlation</i>	0.9895	1	0.99565	0.99882	-0.87236	0.06216	0.988
	<i>p value</i>	<.0001	-	<.0001	<.0001	<.0001	0.3724	<.0001
	<i>N</i>	195	208	196	200	142	208	195
M_t	<i>Pearson Correlation</i>	0.99258	0.99565	1	0.99275	-0.85716	-0.03766	0.98744
	<i>p value</i>	<.0001	<.0001	-	<.0001	<.0001	0.6003	<.0001
	<i>N</i>	195	196	196	196	142	196	195
M*_t	<i>Pearson Correlation</i>	0.98734	0.99882	0.99275	1	-0.88579	-0.00772	0.9885
	<i>p value</i>	<.0001	<.0001	<.0001	-	<.0001	0.9136	<.0001
	<i>N</i>	195	200	196	200	142	200	195
r_t	<i>Pearson Correlation</i>	-0.82057	-0.87236	-0.85716	-0.88579	1	0.70907	-0.84697
	<i>p value</i>	<.0001	<.0001	<.0001	<.0001	-	<.0001	<.0001
	<i>N</i>	141	142	142	142	142	142	141
R*_t	<i>Pearson Correlation</i>	0.00849	0.06216	-0.03766	-0.00772	0.70907	1	0.07892
	<i>p value</i>	0.9063	0.3724	0.6003	0.9136	<.0001	-	0.2728
	<i>N</i>	195	208	196	200	142	208	195
XP_t	<i>Pearson Correlation</i>	0.98777	0.988	0.98744	0.9885	-0.84697	0.07892	1
	<i>p value</i>	<.0001	<.0001	<.0001	<.0001	<.0001	0.2728	-
	<i>N</i>	195	195	195	195	141	195	195

Appendix III. Simple Linear Regressions

(standard errors are reported in parentheses under parameter estimates)

1) Dependent Variable GDP_t

$$GDP_t = -11.21529 + 1.89099M_t^*$$

(-0.2961) (-0.03699)

R-Square: 0.9495

Adj. R-Sq: 0.9491

t value: 51.12

2)

$$GDP_t = 0.68797 + 0.66300M_t$$

(-0.03719) (-0.00726)

R-Square: 0.9836

Adj. R-Sq: 0.9835

t value: 91.38

3)

$$GDP_t = 5.95636 - 0.15224r_t$$

(-0.1355) (-0.00899)

R-Square: 0.6733

Adj. R-Sq: 0.671

t value: -16.93

1) Dependent Variable XP_t

$$XP_t = -13.80565 + 1.93181GDP_t^*$$

(-0.15181) (-0.01762)

R-Square: 0.9886

Adj. R-Sq: 0.9885

t value: 100.63

2)

$$XP_t = -13.78517 + 2.07638M_t^*$$

(-0.20683) (-0.02584)

R-Square: 0.9789

Adj. R-Sq: 0.9788

t value: 80.36

3)

$$XP_t = 5.10766 - 0.16993r_t$$

(-0.13631) (-0.00905)

R-Square: 0.7174

Adj. R-Sq: 0.7153

t value: -18.78

1) Dependent Variable r_t

$$r_t = 2.9786 + 1.52908r_t^* \\ (-0.98742) \quad (-0.13037)$$

R-Square: 0.4974

Adj. R-Sq: 0.4938

t value: 11.73

2)

$$r_t = 87.51507 - 9.25408M_t^* \\ (-3.31055) \quad (-0.41357)$$

R-Square: 0.7827

Adj. R-Sq: 0.7811

t value: -22.38

1) Dependent Variable M_t

$$M_t = -18.00237 + 2.85828M_t^* \\ (-0.34449) \quad (-0.04304)$$

R-Square: 0.96965

Adj. R-Sq: 0.9692

t value: 66.42

Appendix IV. Multiple Linear Regressions

The Reg Procedure

Model: MODEL1

Dependent Variable: GDP_t

Number of Observations Read	278
Number of Observations Read	140
Number of Observations with Missing Values	138

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	8	187.33749	23.41719	1210.22	<.0001
Error	131	2.53478	0.01935		
Corrected Total	139	189.87228			

Root MSE	0.1391	R-Square	0.9867
Dependent Mean	3.89708	Adj. R-Sq	0.9858
Coeff Var	3.5694		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	<i>Intercept</i>	1	1.74234	1.10291	1.58	0.1166
GDP _{t-1}	<i>lagkorgdp</i>	1	-0.1035	0.09481	-1.09	0.277
M* _{t-1}	<i>lagusm2</i>	1	-0.17386	0.16438	-1.06	0.2921
M _{t-1}	<i>lagkorm2</i>	1	0.80309	0.09926	8.09	<.0001
r _{t-1}	<i>lagkorbon</i>	1	0.00495	0.00566	0.88	0.3827
low	<i>low</i>	1	-7.74569	1.55966	-4.97	<.0001
mid	<i>mid</i>	1	0.19854	1.06561	0.19	0.8525
low×M*		1	1.11144	0.21467	5.18	<.0001
mid×M*		1	-0.01888	0.13212	-0.14	0.8866

Appendix IV. Multiple Regressions Cont'd

The Reg Procedure

Model: MODEL1

Dependent Variable: XP_t

Number of Observations Read	278
Number of Observations Read	140
Number of Observations with Missing Values	138

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	8	221.38182	27.67273	2389.39	<.0001
Error	131	1.51718	0.01158		
Corrected Total	139	222.899			

Root MSE	0.10762	R-Square	0.9932
Dependent Mean	2.80739	Adj. R-Sq	0.9928
Coeff Var	3.83336		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	Intercept	1	-6.56934	1.39237	-4.72	<.0001
XP_{t-1}	lagkorp	1	0.57195	0.07543	7.58	<.0001
GDP^*_{t-1}	lagusgdp	1	0.9566	0.28417	3.37	0.001
M^*_{t-1}	lagusm2	1	-0.06375	0.22424	-0.28	0.7766
r_{t-1}	lagkorbon	1	0.00438	0.00449	0.98	0.3313
low	low	1	-1.0366	1.13465	-0.91	0.3626
mid	mid	1	-0.31978	0.71997	-0.44	0.6577
low× M^*		1	0.16343	0.15622	1.05	0.2974
mid× M^*		1	0.04575	0.09205	0.5	0.62

Appendix IV. Multiple Regressions Cont'd

The Reg Procedure

Model: MODEL1

Dependent Variable: r_t

Number of Observations Read	278
Number of Observations Read	141
Number of Observations with Missing Values	137

Analysis of Variance

Source	DF	Squares	Square	F Value	Pr > F
Model	7	5588.98353	798.42622	560.73	<.0001
Error	133	189.37897	1.4239		
Corrected Total	140	5778.3625			

Root MSE	1.19327	R-Square	0.9672
Dependent Mean	13.57392	Adj. R-Sq	0.9655
Coeff Var	8.79093		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	Intercept	1	7.94064	7.4909	1.06	0.291
r_{t-1}	lagkorbon	1	0.87407	0.04722	18.51	<.0001
r^*_{t-1}	lagusbond	1	0.13256	0.08265	1.6	0.1111
M^*_{t-1}	lagusm2	1	-0.89052	0.83028	-1.07	0.2854
low	low	1	-12.43261	12.70846	-0.98	0.3297
mid	mid	1	-9.83265	8.29411	-1.19	0.2379
low×M*		1	1.83363	1.75072	1.05	0.2968
mid×M*		1	1.18838	1.05216	1.13	0.2607

Appendix IV. Multiple Regressions Cont'd

The Reg Procedure

Model: MODEL1

Dependent Variable: M_t

Number of Observations Read	278
Number of Observations Read	195
Number of Observations with Missing Values	83

Analysis of Variance

Source	DF	Squares	Square	F Value	Pr > F
Model	6	1495.8037	249.30062	25491.1	<.0001
Error	188	1.83862	0.00978		
Corrected Total	194	1497.64233			
Corrected Total	194	1497.64233			

Root MSE	0.09889	R-Square	0.9988
Dependent Mean	3.44008	Adj. R-Sq	0.9987
Coeff Var	2.87474		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	Intercept	1	-0.73605	0.4301	-1.71	0.0887
M_{t-1}	lagkorm2	1	0.89887	0.02807	32.03	<.0001
M^*_{t-1}	lagusm2	1	0.16501	0.06599	2.5	0.0133
low	low	1	-1.29376	0.43243	-2.99	0.0031
mid	mid	1	-1.47511	0.65289	-2.26	0.025
low× M^*		1	0.16475	0.05317	3.1	0.0022
mid× M^*		1	0.17901	0.08163	2.19	0.0295

Appendix V. Multiple Regressions without Dummy Variables

(Refer to this appendix for robustness)

The Reg Procedure

Model: MODEL1

Dependent Variable: GDP_t

Number of Observations Read	278
Number of Observations Read	140
Number of Observations with Missing Values	138

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	186.66858	46.66714	1966.5	<.0001
Error	135	3.2037	0.02373		
Corrected Total	139	189.87228			
Root MSE	0.15405	R-Square	0.9831		
Dependent Mean	3.89708	Adj. R-Sq	0.9826		
Coeff Var	3.95293				

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	Intercept	1	-0.5898	0.96632	-0.61	0.5427
GDPt-1	lagkorgdp	1	0.11949	0.09557	1.25	0.2133
M*t-1	lagusm2	1	0.14132	0.14168	1	0.3203
Mt-1	lagkorm2	1	0.56694	0.07678	7.38	<.0001
rt-1	lagkorbond	1	0.01306	0.00495	2.64	0.0093

Appendix V. Multiple Regressions without Dummy Variables Cont'd

The Reg Procedure

Model: MODEL1

Dependent Variable: XP_t

Number of Observations Read	278
Number of Observations Read	140
Number of Observations with Missing Values	138

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	221.30312	55.32578	4680.17	<.0001
Error	135	1.59588	0.01182		
Corrected Total	139	222.899			
Root MSE	0.10873	R-Square	0.9928		
Dependent Mean	2.80739	Adj. R-Sq	0.9926		
Coeff Var	3.87285				

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	Intercept	1	-5.07179	1.12911	-4.49	<.0001
XPt-1	lagkorp	1	0.63635	0.07192	8.85	<.0001
GDP*t-1	lagusgdp	1	0.66989	0.23196	2.89	0.0045
M*t-1	lagusm2	1	0.04132	0.20014	0.21	0.8368
rt-1	lagkorbon	1	0.00259	0.0034	0.76	0.4483

Appendix V. Multiple Regressions without Dummy Variables Cont'd

The Reg Procedure

Model: MODEL1

Dependent Variable: r_t

Number of Observations Read	278
Number of Observations Used	141
Number of Observations with Missing Values	137

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	5576.60285	1858.86762	1262.22	<.0001
Error	137	201.75965	1.4727		
Corrected Total	140	5778.3625			
Root MSE	1.21355	R-Square	0.9651		
Dependent Mean	13.57392	Adj. R-Sq	0.9643		
Coeff Var	8.94029				

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	Intercept	1	10.80553	3.31894	3.26	0.0014
rt-1	lagkorbond	1	0.89136	0.037	24.09	<.0001
r*t-1	lagusbond	1	-0.01372	0.0492	-0.28	0.7807
M*t-1	lagusm2	1	-1.16577	0.36098	-3.23	0.0016

Appendix V. Multiple Regressions without Dummy Variables Cont'd

The Reg Procedure

Model: MODEL1

Dependent Variable: M_t

Number of Observations Read	278
Number of Observations Used	195
Number of Observations with Missing Values	83

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	1495.69352	747.84676	73679.4	<.0001
Error	192	1.9488	0.01015		
Corrected Total	194	1497.6423			
Root MSE	0.10075	R-Square	0.9987		
Dependent Mean	3.44008	Adj. R-Sq	0.9987		
Coeff Var	2.92864				

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	Intercept	1	-1.1076	0.39277	-2.82	0.0053
lagkorm2	lagkorm2	1	0.93337	0.02176	42.89	<.0001
lagusm2	lagusm2	1	0.1838	0.06228	2.95	0.0036

Appendix VI. Multiple Regressions Using Fed Funds Rate

The Reg Procedure

Model: MODEL1

Dependent Variable: GDP_t

Number of Observations Read	278
Number of Observations Read	140
Number of Observations with Missing Values	138

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	8	187.31629	23.41454	1200.05	<.0001
Error	131	2.55599	0.01951		
Corrected Total	139	189.87228			

Root MSE	0.13968	R-Square	0.9865
Dependent Mean	3.89708	Adj. R-Sq	0.9857
Coeff Var	3.5843		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	Intercept	1	0.607	0.27526	2.21	0.0292
GDP _{t-1}	lagkorgdp	1	-0.09583	0.09505	-1.01	0.3153
FFR* _{t-1}	lagusffr	1	-0.00101	0.00669	-0.15	0.8808
M _{t-1}	lagkorm2	1	0.73957	0.07891	9.37	<.0001
r _{t-1}	lagkorbon	1	0.00831	0.00544	1.53	0.129
low	low	1	-7.34524	1.55731	-4.72	<.0001
mid	mid	1	-0.1601	1.07515	-0.15	0.8819
low×M*		1	1.04938	0.21239	4.94	<.0001
mid×M*		1	0.02336	0.1332	0.18	0.861

Appendix VI. Multiple Regression Using Fed Funds Rate Cont'd

The Reg Procedure

Model: MODEL1

Dependent Variable: XP_t

Number of Observations Read	278
Number of Observations Read	140
Number of Observations with Missing Values	138

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	8	221.39615	27.67452	2412.33	<.0001
Error	131	1.50285	0.01147		
Corrected Total	139	222.899			

Root MSE	0.10711	R-Square	0.9933
Dependent Mean	2.80739	Adj. R-Sq	0.9928
Coeff Var	3.81521		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	Intercept	1	-6.42941	1.38658	-4.64	<.0001
XP_{t-1}	lagkorp	1	0.58584	0.0755	7.76	<.0001
GDP^*_{t-1}	lagusgdp	1	0.87709	0.17765	4.94	<.0001
FFR^*_{t-1}	lagusffr	1	-0.00591	0.00513	-1.15	0.2507
r_{t-1}	lagkorbon	1	0.00637	0.00458	1.39	0.1667
low	low	1	-0.75386	1.14969	-0.66	0.5132
mid	mid	1	0.01571	0.7671	0.02	0.9837
low×M*		1	0.12367	0.15808	0.78	0.4354
mid×M*		1	0.0052	0.097	0.05	0.9573

Appendix VI. Multiple Regression Using Fed Funds Rate Cont'd

The Reg Procedure

Model: MODEL1

Dependent Variable: r_t

Number of Observations Read	278
Number of Observations Read	141
Number of Observations with Missing Values	137

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	5590.06853	798.58122	564.07	<.0001
Error	133	188.29397	1.41574		
Corrected Total	140	5778.3625			

Root MSE	1.18985	R-Square	0.9674
Dependent Mean	13.57392	Adj. R-Sq	0.9657
Coeff Var	8.76571		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	Intercept	1	0.03909	0.39074	0.1	0.9205
r_{t-1}	lagkorbon	1	0.90643	0.03372	26.88	<.0001
r^*_{t-1}	lagusbond	1	0.04465	0.11587	0.39	0.7006
FFR^*_{t-1}	lagusffr	1	0.11715	0.08447	1.39	0.1678
low	low	1	-6.61688	9.71631	-0.68	0.4971
mid	mid	1	-12.64443	8.41705	-1.5	0.1354
low×M*		1	1.10971	1.39138	0.8	0.4265
mid×M*		1	1.58245	1.06633	1.48	0.1402

Appendix VI. Multiple Regression using Fed Funds Rate Cont'd

The Reg Procedure

Model: MODEL1

Dependent Variable: M_t

Number of Observations Read	278
Number of Observations Read	195
Number of Observations with Missing Values	83

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	1495.74502	249.29084	24701.7	<.0001
Error	188	1.8973	0.01009		
Corrected Total	194	1497.64233			

Root MSE	0.10046	R-Square	0.9987
Dependent Mean	3.44008	Adj. R-Sq	0.9987
Coeff Var	2.92026		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	Intercept	1	0.32	0.11114	2.88	0.0044
M_{t-1}	lagkorm2	1	0.95417	0.01719	55.51	<.0001
FFR^*_{t-1}	lagusffr	1	-0.00191	0.00386	-0.49	0.6212
low	low	1	-1.40567	0.45671	-3.08	0.0024
mid	mid	1	-1.40887	0.73574	-1.91	0.057
low×M*		1	0.18106	0.05712	3.17	0.0018
mid×M*		1	0.17359	0.09158	1.9	0.0596

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